FMEA-Ranking Scales

Process-FMEA - Overview

Severity (S)

Effect	Criteria: Severity of Effect	Rank
Endangerment of health and life of humans	Very high Severity: Failure affects safe vehicle operation. Health and life of passengers are endangered. It could lead to an existence threatening company risk.	10
Noncompliance with government regulation	Very high Severity: Failure involves violating the compliance to legal regulations or noncompliance with government regulations. Humans are not endangered.	9
Very high	Vehicle/ function inoperable (Loss of Primary Function – walk home). Major disruption of production: System cannot be assembled at the final assembly at the OEM belt.	8
High	Vehicle/ function is operable, but at a reduced level. The customer is very dissatisfied. (limp home) Significant disruption of production: cannot be assembled at the final assembly at the tier 1 belt.	7
Moderate	Vehicle/ function is operable, but comfort functions are not available. The customer is dissatisfied. Moderate disruption of production: System cannot be assembled at the pilot belt at the Tier 1.	6
Little	Vehicle/ function is operable, but comfort functions are working at a reduced level. The customer is somewhat dissatisfied. Moderate disruption of production: System cannot be assembled at the prototype building.	5
Very little	Fit & appearance / noises are disturbing. Failure is noticed by most customers (>75%). Minor disruption of production: 100% % of the production run may have to be reworked in station.	4
Low	Fit & appearance / noises are disturbing. Failure is noticed by many customers (>50%). Low inconvenience of production: A portion of the production run may have to be reworked in station.	3
Very low	Fit & appearance / noises are disturbing. Failure is noticed by some customers (<25%). Very low inconvenience of production: Slight inconvenience to process, operation or operator.	2
None	No discernible effect. No inconvenience in production.	1

Occurence (O)

Likelihood	Criteria: Potential Failure Rates	Rank
Always	New process without experience. 100.000 ppm / 1 failure per 10 parts / C_{pk}=0,43 Permanent failure	10
Very high	New process without experience. 50.000 ppm / 1 failure per 20 parts / C_{pk}=0,55 Multiple failures per hour	9
High	New process with known but problematic procedure. 20.000 ppm / 1 failure per 50 parts / Cpk=0,68 One failure per hour	8
Significant	New process with known but problematic procedure 10.000 ppm / 1 failure per 100 parts / C_{pk}=0,77 One failure per shift	7
Moderate	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 2.000 ppm / 1 failure per 500 parts / Cpk=0,96 Multiple failures per day	6
Moderate	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 500 ppm / 1 failure per 2.000 parts / Cpk=1,1 One failure per week	5
Minor	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 100 ppm / 1 failure per 10.000 parts / Cpk=1,24 One failure per month	4
Low	Changes to detail on mature processes with positive production experience under comparable conditions. 10 ppm / 1 failure per 100.000 parts / Cpk=1,42 One failure per quarter	3
Very low	Changes to detail on mature processes with positive production experience under comparable conditions. 1 ppm / 1 failure per 1.000.000 parts / Cpk=1,58 One failure per year	2
Unlikely	New process under altered conditions with positively completed proof of machine and process capability. Mature process with positive production experience under comparable conditions and comparable machines. ≤ 1 ppm / ≤ 1 failure per 1.000.000 parts Less than 1 failure per year	1

Detection (D)

Detection	Criteria: Likelihood, that test procedure will detect the failure	Rank
NOT detected	Almost Impossible: no current process control; Cannot be detected or is not analysed. 1 in 2 failures will not be detected / Cpk ≤ 0,33 No failure detection	10
Discovered coincidentally only	Failure Mode and/ or Error (cause) is not easily detected. Only random proof procedures (audits) have been established. 1 in 10 failures will not be detected / Cpk ≥ 0,33 10% not detected failures	9
Accidentally discovered	Failure Mode and/ or Error (cause) is not easily detected. Detection post-processing by operator through visual / tactile / audible means. 1 in 20 failures will not be detected / Cpk ≥ 0,67 5% not detected failures	8
Very low probability	Failure Mode will be detected in-station by operator through visual / tactile / audible means or post-processing through use of attribute gauges (go/ no-go, manual torque check/clicker wrench, etc.) 1 in 50 failures will not be detected / Cpk ≥ 1,00 2% not detected failures	7
Low probability	Failure Mode will be detected post-processing by operator through use of variable gauging or in station by operator through use of attribute gauges (go/ no-go, manual torque check/clicker wrench, etc.). 1 in 100 failures will not be detected / Cpk ≥ 1,33 1% not detected failures	6
Moderate probability	Error (Failure Cause) will be detected in-station by operator. Therefore variable gauges or automated controls in-station are used to detect discrepant part and to notify operator (light, buzzer, etc Gauging performed on setup and first-piece check (for set-up causes only). 1 in 200 failures will not be detected / Cpk ≥ 1,5 0,5% not detected failures	5
Reasonable probability	Failure Mode will be detected post-processing by automated controls that will detect discrepant parts and lock parts to prevent further processing. 1 in 500 failures will not be detected / Cpk ≥ 1,67 0,2% not detected failures	4
High probability	Error (Failure Cause) will be detected in station by automated controls that will detect the failure and prevent discrepant part from being made. 1 in 1.000 failures will not be detected / Cpk ≥ 1,83 0,1% not detected failures	3
Very high probability	Error (Failure Cause) will be detected in station by automated controls that will detect the failure and prevent discrepant part from being made. 1 in 10.000 failures will not be detected / Cpk = 2,0 0,01% not detected failures	2
Certainly	Error (Cause) will be prevented as a result of fixture design, machine design or part design. Discrepant parts cannot be made because item has been error-proofed by process and / or product design. Failure cannot occur. / Cpk ≥ 2,0 Less than 0,01% not detected failures	1

Process-FMEA - Severity

Effect	Criteria: Severity of Effect	Rank
Endangerment of health and life of humans	**Health and life of humans are endangered:** Failure affects safe vehicle operation. Health and life of passengers / road users / operator / other operators are endangered. It could lead to an **existence threatening company risk**.	10
Noncompliance with government regulation	**Potential failure mode involves noncompliance with government regulation:** Failure involves violating the compliance to legal regulations or noncompliance with government regulations. Humans (passengers / road users / operator / other operators) are not endangered. **Unacceptable cost overrun is possible.**	9
Loss of Primary Function Walk Home	**Loss of Primary Function:** Driving is not possible. The customer is extraordinary dissatisfied. (Loss of primary function – walk home – vehicle stands still => driver has to walk. Vehicle slows down, no hazard of an accident.) **Major disruption of production**: System cannot be assembled / flashed at the final assembly at the OEM (line stopper). 100% of products may have to be scrapped – delivery stop.	8
Degradation of Primary Function Limp Home	**Degradation of Primary Function:** The vehicle is operable, but at a reduced level. The customer is very dissatisfied. Immediate stay in the garage is imperatively necessary. (Limp home – vehicle can be driven in reduced mode only, e.g. limitation of maximum engine speed.) **Significant disruption of production**: System cannot be assembled / programmed at the final assembly at the tier 1 (line stopper). A portion of the production run may have to be scrapped. Deviation from primary process; decreased line speed or added manpower.	7
Loss of convenience function	**Loss of Secondary Function:** The vehicle is operable, but comfort functions are not available. The customer is dissatisfied. (Air condition is not working, window cannot be opened, hybrid has no function.) **Moderate disruption of production**: System cannot be assembled at the pilot belt or fails at the end of line test at the Tier 1. 100% of the production run may have to be reworked off line and accepted	6
Degradation of convenience function	**Degradation of Secondary Function**: The vehicle is operable, but comfort functions are working at a reduced level. The customer is somewhat dissatisfied. (Air condition is not working properly, window opens slowly, radio disturbance, hybrid has no full function.) **Moderate disruption of production**: System cannot be assembled at the prototype building / set into function or fails at the function test. A portion of the production run may have to be reworked offline and accepted.	5
Sensory disturbance (high)	**Fit & appearance / noises are disturbing**: Failure is noticed by most customers (>75%). (Almost all customers will notice the failure, even non-critical representatives!) Disturbance of our senses: hearing / seeing / feeling / smelling / (tasting) **Minor disruption of production**: 100% of the production run may have to be reworked in station before it can be processed.	4
Sensory disturbance (moderate)	**Fit & appearance / noises are disturbing**: Failure is noticed by many customers (>50%). (On average every second customer will notice the failure.) Disturbance of our senses: hearing / seeing / feeling / smelling / (tasting) **Low inconvenience of production**: A portion of the production run may have to be reworked in station before it can be processed.	3
Sensory disturbance (low)	**Fit & appearance / noises are rarely disturbing**: Failure is noticed by some customers (<25%). (Those customers can hear the grass growing. ☺) Disturbance of our senses: hearing / seeing / feeling / smelling / (tasting) **Very low inconvenience of production**: Slight inconvenience to process, operation or operator.	2
None	**No discernible effect**: Only identifiable by qualified personnel. (But out of tolerances; at this point the tolerances have to be considered.) **No inconvenience in production**.	1

Rankings of failure effects have to be aligned common between manufacturer and customer (next recipient).
If failure effects are not known, severity has to be ranked with mit S = 10!

Process-FMEA - Likelihood of Occurence

Likelihood of failure	Criteria: Potential Failure Rates	Rank
Always	New process without experience. 100.000 ppm / 1 failure per 10 parts / Cpk=0,43 Permanent failure	10
Very high	New process without experience. 50.000 ppm / 1 failure per 20 parts / Cpk=0,55 Multiple failures per hour	9
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Moderate	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 2.000 ppm / 1 failure per 500 parts / Cpk=0,96 Multiple failures per day	6
Moderate	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 500 ppm / 1 failure per 2.000 parts / Cpk=1,1 One failure per week	5
Minor	New process carrying over known procedure. Mature process with positive production experience under altered conditions. 100 ppm / 1 failure per 10.000 parts / Cpk=1,24 One failure per month	4
Low	Changes to detail on mature processes with positive production experience under comparable conditions. 10 ppm / 1 failure per 100.000 parts / Cpk=1,42 One failure per quarter	3
Very low	Changes to detail on mature processes with positive production experience under comparable conditions. 1 ppm / 1 failure per 1.000.000 parts / Cpk=1,58 One failure per year	2
Unlikely	New process under altered conditions with positively completed proof of machine and process capability. Mature process with positive production experience under comparable conditions and comparable machines. ≤ 1 ppm / ≤ 1 failure per 1.000.000 parts Less than 1 failure per year	1

The ranking is always to be understood as a relative assessment rather than an absolute measure according to the current state of knowledge.
A confirmation or correction of the assessment may be made after the implementation of the action and its effectiveness check and the availability of new data.

Process-FMEA - Likelihood of Detection

Detection	Criteria: Likelihood, that test procedure will detect the failure	Rank
NOT detected	Almost Impossible: **no current process control**; Cannot be detected or is not analysed. 1 in 2 failures will not be detected / Cpk ≤ 0,33 No failure detection	10
Discovered coincidentally only	Failure Mode and/ or Error (cause) is not easily detected. **Only random proof procedures (audits)** have been established. 1 in 10 failures will not be detected / Cpk ≥ 0,33 10% not detected failures	9
Accidentally discovered	Failure Mode and/ or Error (cause) is not easily detected. Detection **post-processing by operator through visual / tactile / audible means**. 1 in 20 failures will not be detected / Cpk ≥ 0,67 5% not detected failures	8
Very low probability	Failure Mode will be detected **in-station by operator through visual / tactile / audible means or post-processing through use of attribute gauges** (go/ no-go, manual torque check/clicker wrench, etc.) 1 in 50 failures will not be detected / Cpk ≥ 1,00 2% not detected failures	7
Low probability	Failure Mode will be detected **post-processing by operator through use of variable gauging or in station by operator through use of attribute gauges** (go/ no-go, manual torque check/clicker wrench, etc.). 1 in 100 failures will not be detected / Cpk ≥ 1,33 1% not detected failures	6
Moderate probability	Error (Failure Cause) will be detected **in-station by operator. Therefore variable gauges or automated controls in-station are used to detect discrepant part and to notify operator (light, buzzer, etc Gauging performed on setup and first-piece check (for set-up causes only).** 1 in 200 failures will not be detected / Cpk ≥ 1,5 0,5% not detected failures	5
Reasonable probability	Failure Mode will be detected **post-processing by automated controls that will detect discrepant parts and lock parts to prevent further processing**. 1 in 500 failures will not be detected / Cpk ≥ 1,67 0,2% not detected failures	4
High probability	Error (Failure Cause) will be detected **in station by automated controls that will detect the failure and prevent discrepant part from being made**. 1 in 1.000 failures will not be detected / Cpk ≥ 1,83 0,1% not detected failures	3
Very high probability	Error (Failure Cause) will be detected **in station by automated controls that will detect the failure and prevent discrepant part from being made**. 1 in 10.000 failures will not be detected / Cpk = 2,0 0,01% not detected failures	2
Certainly	Error (Cause) will be prevented as a result of fixture design, machine design or part design. **Discrepant parts cannot be made because item has been error-proofed by process and / or product design**. Failure cannot occur. / Cpk ≥ 2,0 Less than 0,01% not detected failures	1